

Assessment of Changes in Canopy Closure in Response to Douglas Fir Tussock Moth Outbreak and Subsequent Aerial Control Project, USFS, Methow Valley Ranger District, Washington.

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INTRODUCTION

Based on “early warning system” data 1997-2000 and extensive field larval surveys in 1999, an outbreak of Douglas Fir Tussock Moth (*Orgyia pseutotsuga*) was anticipated in the Methow Valley of Washington, and the Forest Service proposed an action to suppress the outbreak using a naturally occurring, host specific, nucleopolyhedrosis virus that was cultured and developed by the Forest Service into a sprayable product called TM Biocontrol-1.

Because this was the second large scale application of this virus (the first was 1999 in Oregon) and effects of this process were undocumented, an extensive effort to monitor the spray application, its effectiveness, and the consequences for wildlife, fish, and Forest users was undertaken. The retention of forest canopy was one of the most significant reasons for the project. Determining the ability of the project to limit damage caused by this defoliating insect was a key aspect of follow-up monitoring.

This is one of two reports that addresses the results of two years of monitoring focusing on canopy defoliation. The other report by team entomologist Connie Mehmel, agrees with the findings of this effort.

STUDY AREA

Within the Methow Valley outbreak area, several units were identified where treatment was possible due to predicted epidemic concentrations of tussock moth larvae. These included Cub Creek, Eight Mile, Twisp River, Wolf Creek, and Mazama. Ultimately the Mazama area was the only large area where sufficient larvae were found prior to treatment to justify an assessment of canopy effects.

METHODS

Field Methods

After evaluating conventional methods of assessing canopy closure a new method was developed using comparative analysis of printed digital photographs. Canopy closure was evaluated before and after spraying at 19 locations in unsprayed areas and at 22 locations in sprayed areas. At each location, the change in canopy closure was measured as the mean difference before and after spraying at 20 photo points spaced 20 meters apart along a 100 meter x 100 meter square transect located in cardinal directions from a

designated corner point (Figure 1). This resulted in collecting and analyzing over 1600 photographs and 160,000 individual measures of the canopy.

A digital photograph was taken vertically at each marked location with the camera body oriented along a north south axis, 4 feet above the ground, positioned directly above the stake. Each photograph was printed and manually reviewed for its representative percentage of canopy by overlaying a 100 point grid and counting “hits” and “misses” on the grid.

We attempted to measure before and after canopy closure at exactly the same 20 points marked with stakes in successive years (2001 vs. 2002) in May and early June each year. In some cases a photo point could not be exactly relocated, so the photo point was estimated as closely as possible. To see if those estimated points resulted in some bias in canopy change estimation, we calculated change in canopy closure in two ways. First, only points where the photo location was exactly known (designated as “exact locations” below) were used to estimate canopy change. In those cases, the number of points averaged at each location ranged from 13 to 20, but averaged 19 points. Second, we estimated canopy change using both exact and estimated points to average 20 points at a location (designated as “20 point” locations).

Data Analysis

We calculated change in canopy closure in sprayed vs. unsprayed areas as the average (median) change at 19 and 22 locations, respectively. We displayed the effect of the spray treatment on canopy closure with box plots. The length of each box shows the “midrange” of values within which the central 50% of the values fall. The “whiskers” extending from the box show the range of the central 75% of values. Symbols outside the whiskers show values outside the central 75% range of values.

We evaluated the strength of spray effects on change in canopy closure by the extent of overlap in the midrange (box) of boxplots with the zero-change reference line and between sprayed vs. control areas. We did not do formal statistical tests to estimate the significance of the difference in canopy closure between sprayed and unsprayed areas because limitations posed by the tussock moth outbreak and spray treatment areas provided no true replicates of sprayed and unsprayed conditions for hypothesis testing

For statistical analysis purposes there was only one contiguous sprayed area and one contiguous unsprayed area from which to estimate treatment effects. As such spray effects could not be separated from effects associated with location, i.e., multiple discontinuous spray and control units were not able to be measured. (Tim Max, Statistician, PNW Research Station, Portland, OR, personal communication).

RESULTS

Contrary to expectations, canopy closure appeared to decline more in sprayed (4.5%) than unsprayed control (1.5%) areas (Table 1, Figures 2 & 3). Change in canopy closure in unsprayed control areas probably did not differ from zero given the overlap of the

midrange with the zero reference line. In sprayed locations there was stronger evidence of a slight decline in canopy closure in sprayed areas because the midrange of values did not overlap the zero reference. Nevertheless, the apparent difference between sprayed and control areas seemed weak because midrange values overlapped about 50%. There was little difference between exact-point and 20-point samples.

Table 1. Average (median) change in canopy closure in unsprayed and sprayed tussock moth project areas in the upper Methow Valley during 199x and 199x.

Sample type	Unsprayed	Sprayed	Total
20 point samples (n = 19)	-1.55	-4.80	-3.50
Exact point samples (n = 22)	-1.60	-4.18	-3.21

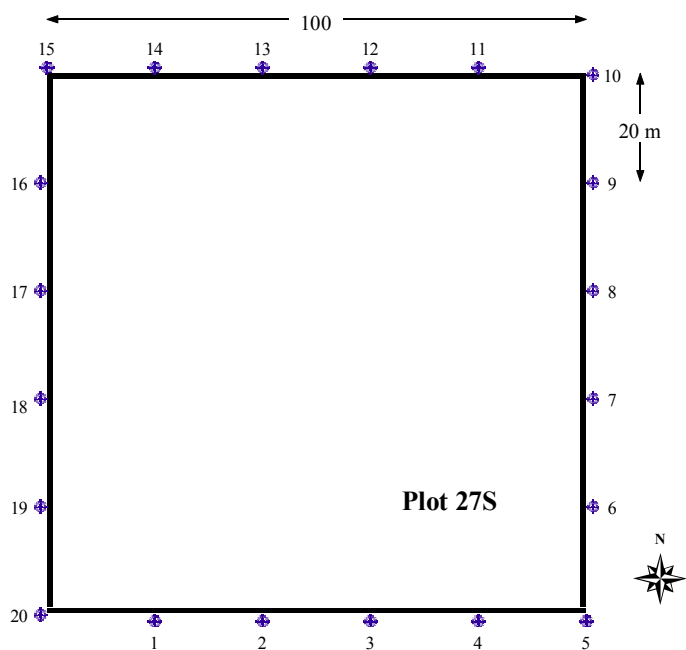


Figure 1. Arrangement of photo points in each plot used to measure canopy closure. 20 photos per plot before and after spraying.

Canopy closure - 20 sample points

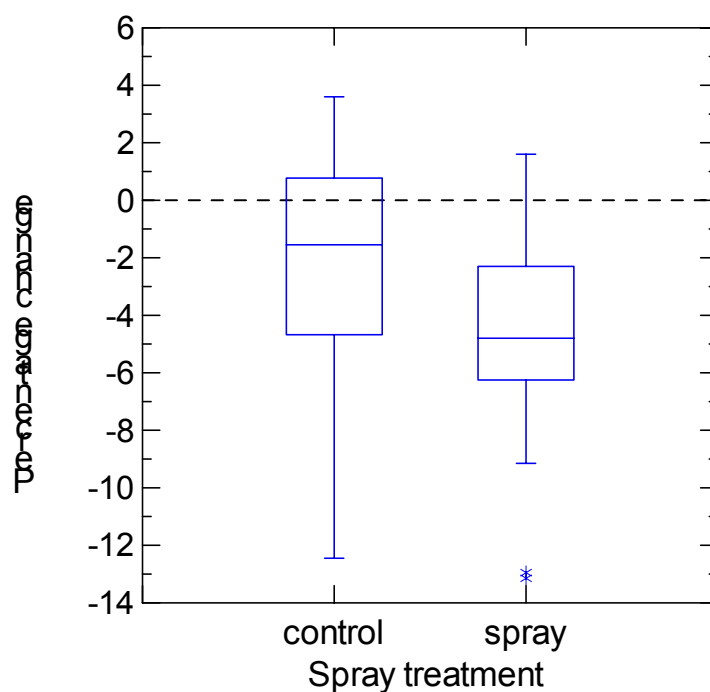


Figure 2. Percentage change in canopy closure on unsprayed control and sprayed areas in the Methow Valley tussock moth spray project during 199x and 199x. Canopy closure was estimated from 20 photo points at each sample location (see text for explanation). Bar in box is the average (median) value. Length of box indicates the central 50% of values. Whiskers from box show the central 75% of values. Symbols beyond whiskers are outlying values.

Canopy closure - Exact sample points

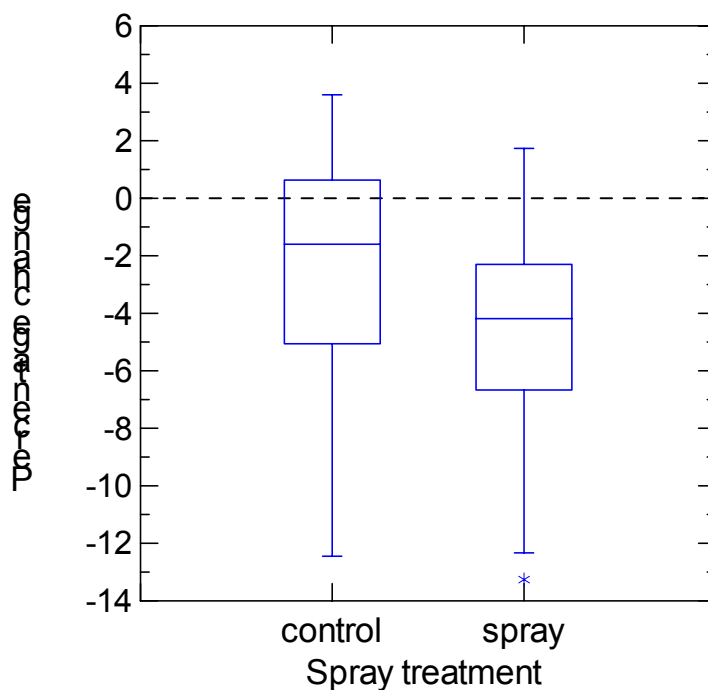


Figure 3. Percentage change in canopy closure on unsprayed control and sprayed areas in the Methow Valley tussock moth spray project during 199x and 199x. Canopy closure was estimated from exact photo points at each sample location (see text for explanation). Bar in box is the average (median) value. Length of box indicates the central 50% of values. Whiskers from box show the central 75% of values. Symbols beyond whiskers are outlying values.

Discussion

The assumption for the spray project that defoliation induced losses in canopy closure would have a detrimental effect on some species of wildlife was probably a valid one. The estimated threshold for ecological significance was a 20% loss of canopy closure. It was suggested that losses below that threshold might have little impact to wildlife. Spotted owls and other late successional forest species, as well as declining fish species were focal targets of this canopy protection goal.

The methodology employed was valuable in documenting changes in canopy closure at the selected sites. Statistical analyses showed that small changes can be measured with significance.

The canopy closure photo analysis method was able to detect a measurable change from 2001 to 2002 in the sprayed area monitored. A -4.6% change was noted with a significance of $P=0.005$. However, our ability to attribute this change to a particular factor is limited since no replicates were possible based on the configuration of the outbreak and the desire to treat specific areas.

The ultimate outcome of the outbreak was that little change occurred in either treatment or control portions of the project area. It is possible that this was due to the natural collapse of the tussock moth population. The largest changes measured in the 41 plots monitored were a -13.3% change in a sprayed plot from one year to the next and a -12.5% change in a control plot. Overall the change in canopy was less than -5% for the entire area monitored.

We have confidence that, after testing this methodology, those figures are representative of what actually occurred in those sites. The goal of implementing a scientific, repeatable, credible assessment of canopy loss was met. We also have confidence that the consequences of this particular outbreak to wildlife were in fact very small – both from the treatment effort, and the minimal loss of canopy.

The Final Report of this project <http://www.fs.fed.us/r6/nr/fid/dftmweb/project01/2001-dftm-final-b.pdf> has additional details of monitoring the effects this spray effort on owls, bats, songbirds, and peregrine falcons.

Future monitoring design for canopy loss will benefit from replication to further clarify the efficacy of spraying compared with no treatment in retaining canopy of host trees. The unpredictability of tussock moth distribution and population cycles will certainly be a challenging factor to incorporate in such a design.